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ABSTRACT

This document is a collection of six energy education activities for junior high school science. Its purpose is to help promote knowledge about energy, provide laboratory experiences, provoke inquiry, and relate energy to society through the science curriculum. The six activities are designed to take one to three class periods. Two of the activities have activity options included. Each activity provides some background information, an activity description including a materials list, evaluation questions, and a resources list. Several activities also include student worksheets. Activity titles are: (1) Star Power; (2) Energy: Wha(tt) Is It?; (3) Rube's In(nova)tion; (4) Killerwatts; (5) Sc/avenging Energy; and (6) What If...? The skills that the activities are intended to teach include hypothesis formation, collecting and analyzing data, observation and inference, decision making, chart and table reading, and the application of science to other areas of life. (MR)

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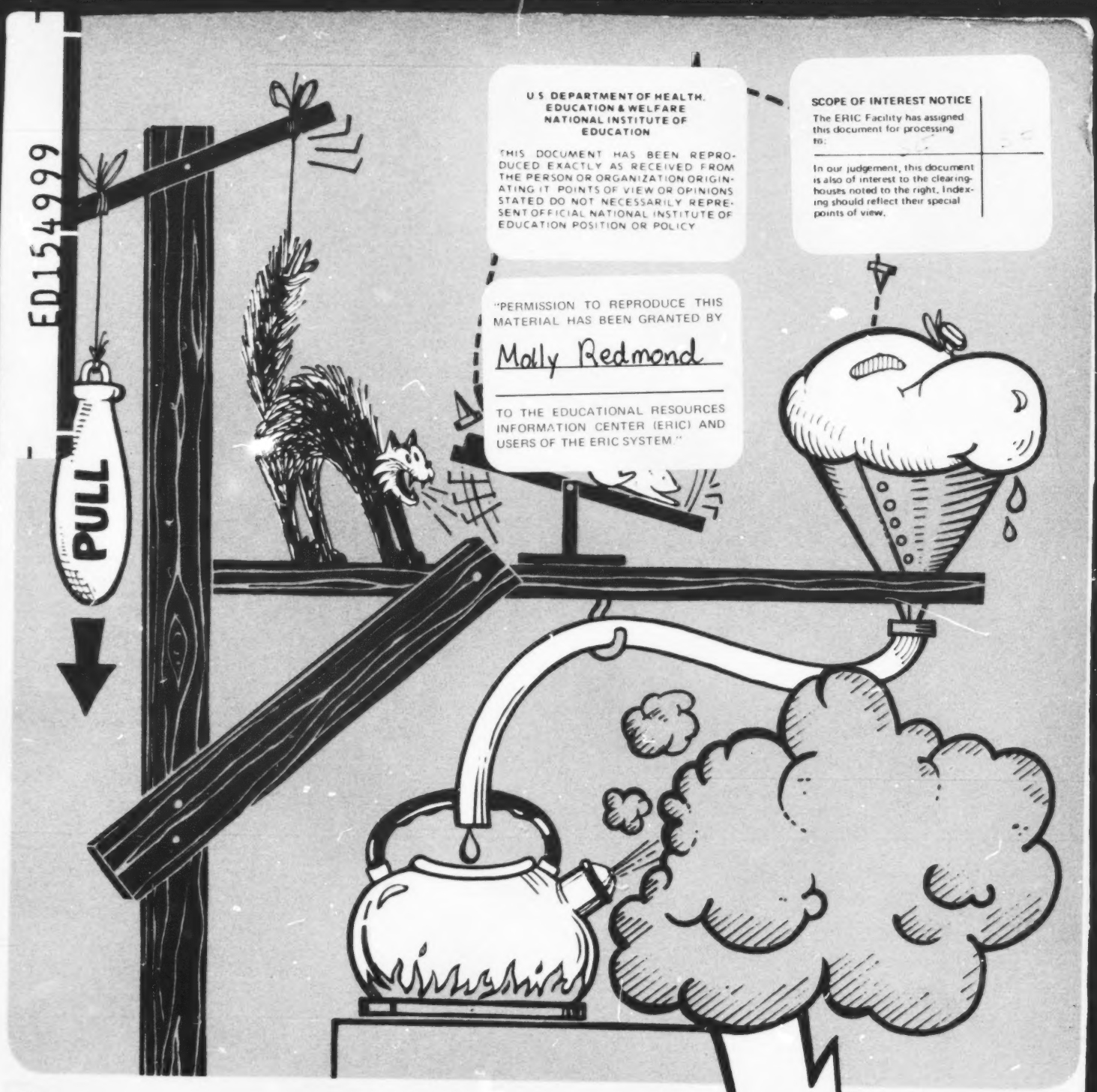


SE 024 223

ENERGY ACTIVITIES for junior high SCIENCE

2

the source of the acronym TANSTAAFL (There Ain't No Such Thing As A Free Lunch). It tells us that energy cannot be manufactured from nothing. Energy can be transformed from one form to another.

The second energy law is known as the Second Law of Thermodynamics and is often called the Entropy Law. It tells us that:

In any conversion of energy from one form to another some of the energy becomes unavailable for further use.

This law is also known as the Heat Tax or the "Things are Going to Get Worse Law." It says that in every energy conversion some energy becomes heat and is no longer available for human use. It can be thought of as what happens when an ordered system — a gallon of gas — is used and changed into a disordered system — heat, water, and carbon compounds.

The word entropy is used by scientists to indicate how random or disordered a system is. The more disorder in a system, the higher the entropy. The idea of entropy and a statement of the Second Law is found in a familiar nursery rhyme:

Humpty Dumpty sat on a wall
Humpty Dumpty had a great fall
All the King's horses
And all the King's men
Couldn't put Humpty together again.

When a deck of playing cards is arranged by suits and rank, the system has low entropy or high order. If the cards are thrown and scattered across a room, the entropy or disorder of the deck of playing cards is greatly increased. In order to reorder the deck, some energy must be expended. Try it!

SUM/MARY

In this activity, students develop an explanation of energy and invent/devise ways of showing someone what energy is.

DE/SCRIPT/ION

Some Materials Needed: magnifying glasses, concave mirrors, thermometers, ice cubes, plastic tubing, assorted plastic containers, scissors, vermiculite, fiberglass or mineral wool insulation, plastic bags, packing materials.

Part 1. Ask students to find some examples of kinetic energy, potential energy, energy flow and energy change in their classroom, their school, their home and their community. They are to design a simple experiment which shows that energy is flowing and that it changes as it flows. You may want students to work in pairs/small groups on the design of an experiment or measurement or observation which shows energy flow and change. Do not let the materials listed above limit your and their attempts.

You might challenge students to prove, for example, that energy flows naturally from hot objects to cold objects. You could challenge students to attempt to store energy for a period longer than that energy storage would occur naturally. For example, can they keep something cold (an ice cube contest) or warm for a long period of time? You might challenge them to see if they can devise a way to store the energy of the sun for a particular period of time.

Part 2. Ask students to design and do an experiment to show another person what energy is. They might use, for example, concave mirrors, magnifying lenses, thermometers (and other things) to help them show a person what energy is.

Part 3. Now that they have done this have each participant write an explanation of what they think energy is and then share their explanation in a small group (four to six). After they share their explanation of energy ask them to write a group explanation of energy. It should include the thinking of each participant in the group. It is important that one person not write the explanation and the others passively agree to it, but that all group members contribute their thinking to the explanation. Groups should also give their reasons for what they think energy is.

E/VALU/ATION

1. Is it important to be able to explain energy? Is it important to you? Does it give you a better understanding of what energy is?
2. What is the best way to learn about energy?
3. What is one thing you would like to know about energy?
4. In what ways are you like an animal, such as a squirrel or rabbit, in your use of energy? In what ways are you different from animals in your use of energy?
5. What relationship is suggested between energy flow and money flow by the cartoon below? Is this cartoon a reasonable definition of energy? Are dollar bills energy units? In what way(s)?

RE/SOURCES

Matthews, J. (1975) Energy, entropy and intuition. p. 8 in Energy Activity Guide by Anne Bull, Loran Fraser, Kirk Marckwald, Becky Millikan, and Nancy Carlson Shirk. Park Project on Energy Interpretation. National Recreation and Park Association, 1601 North Kent Street, Arlington, Virginia 22209 (free)

CONTENTS

1 **STARPOWER.** Students construct a simple solar heat collector and take some temperature measurements. There are two activity options. In the first one, students improve upon the heat collecting and retaining ability of a simple heat collector. In the second option, more specific instructions are given. Student worksheets which can be duplicated are included.

The activity promotes the skills of hypothesis formation and the design of an experiment to test it; understanding solar radiation; and collection and analysis of data.

2 **ENERGY: WHA(TT) IS IT?** Students develop an explanation of energy and invent devise ways of showing someone what energy is.

The activity promotes hypothesis formation and experimental design; the collection and recording of simple observations from observations and measurements.

3 **RUBE'S IN(NOVA)TION.** In this open and free-ranging activity students design invent an energy converter which uses an energy resource such as wind, gravity, or the sun, which demonstrates the first law of energy — energy can neither be created nor destroyed but it can be transformed from one form to another. Parents, neighbors, older brothers and sisters can be invited to help and participate in the proceedings. A short activity on changes as a match or candle burns sets the stage for this student investigation.

The activity promotes consideration of cause and effect, and designing an investigation.

4 **KILLERWATTS.** Participants outfit a home with electrical appliances with emphasis on limiting electrical energy consumption. Two activity options are provided. Students can compare their energy use with the energy use of an energy conscious family or they can compare their electrical energy consumption with energy use in their own home. This activity offers an opportunity for involvement of household members. Student worksheets which can be duplicated are provided.

The activity promotes the use of scientific information in personal decision making and recognizing information placed in a table or char

5 **SCAVENGING ENERGY.** An open-ended activity in which students are asked to go on an energy awareness scavenger hunt and to do some experiments to "prove" their observations. A demonstration activity — an "experiment" — is suggested that raises some questions about experimental design and proof. A student worksheet which can be duplicated is provided.

The activity promotes the skill of prediction, learning to isolate variables, experimental design and rules of proof.

6 **WHAT IF . . . ?** Through the use of "what if" questions, learners are provided an opportunity to express their thoughts and feelings about current energy dilemmas.

The activity explores the relation of science to society; the application of science to other areas of life; and raises the question about what we do when there are no right or wrong answers.

WHAT IF . . . ?

The energy crisis is filled with a whole series of "what if's?" They are important questions because they are beginning points that lead to reactions and responses. There are no "right" answers to them but rather a range of possibilities. "What if" questions can take advantage of as much information as is available or they can start with persons having an opportunity to share what they think and feel about a particular issue. These kinds of questions promote divergent and alternative thinking as well as increased awareness about the energy situation.

SUM/MARY

Through the use of "what if" questions learners are provided an opportunity to express their thoughts and feelings about current energy dilemmas.

DE/SCRIPT/ION

Pose a current energy dilemma and encourage participants to respond in as much detail as they can. Encourage both information and imagination. You may want participants to work as a class, in small groups or to respond to student and teacher ideas by writing a short story or a play. Some examples of "what if's" follow:

What if your family had one car, were allowed to use one gallon of gas per week and that one gallon would take you 25 miles? **What if** you could use two gallons?

What if the energy required to heat your house cost twice what it does now (What would you be willing to give up either to reduce the amount of energy required to heat your home or to help pay for the additional cost?)

What if your family had been given its last tank of gasoline? After the use of that final tank there will be no more available. What would you do with the last tank of gasoline? Where would you go? What would you take? (You

persons with whom you live to find out their thoughts and ideas so that you can represent them fairly!)

What if you were asked to reduce your energy consumption by 10 percent? by 20 percent? by 50 percent?

What if gasoline stations were closed every weekend?

What if people do not respond positively to the request to reduce their energy consumption?

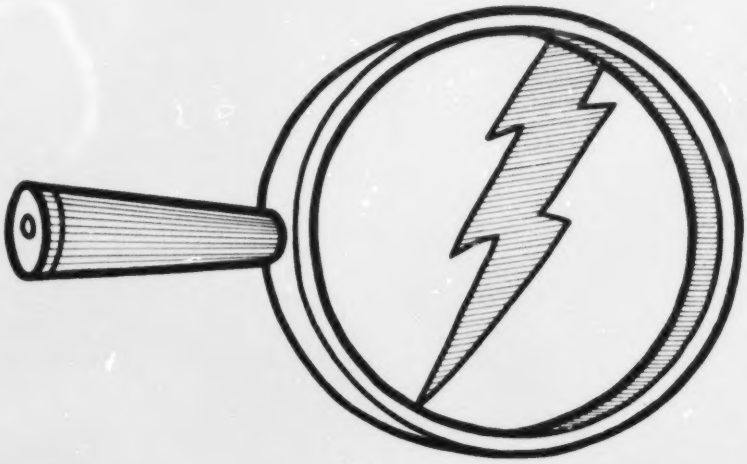
What if there were to be no school athletic programs because of the energy crisis?

Invent your own "what if's" and use them as you teach and learn about energy.

E/VALU/ATION

This activity provides its own evaluation. Use the sharing and discussion to help your students clarify the implications of their choices.

SC/AVENGING ENERGY



Exploring, experimenting and experiencing are paths towards awareness. Awareness is one of those slippery words which environmentalists, particularly environmental educators, use a lot. It can involve the senses — seeing, hearing, smelling, tasting, touching. It can involve feelings and emotions. It also includes the use of imagination, guessing, thinking, experimenting: all things that help us to explain the world.

SUM/MARY

In this open-ended activity, participants are asked to go on an energy awareness scavenger hunt and do some experiments to prove their observations. A demonstration activity — an "experiment" — is included that raises some questions about experimental design and proof. A student worksheet which can be duplicated is provided.

DE/SCRIPT/ION

Some Materials Needed: flasks, test tubes, alcohol burners, test tube clamps, thermometers.

1. You may want to introduce this activity with an experiment that illustrates what is meant by "proof". The suggested activity is an old problem: Which boils faster, warm water or cold water? If your class does not split on this question, you can pose this problem: How would you prove it to someone who wasn't sure? If you choose to have students attempt this activity, it is important to let them get started with a minimum of instructions. When the first part of the activity is completed, have students report their findings both on paper and to the class.

After all the students have had a chance to report (and have reported conflicting results), have them try to isolate as many variables as possible that are related to the experiment:

a. starting temperatures of water (same in both samples?)

b. volume of water heated (same in both samples?)

c. what was the energy source used to heat the water?

d. does the container the water was heated in make a difference (flasks, test tubes)?

e. length of time the water samples were heated (same or different for everyone?)

f. number of trials (more than one?)

It is important to have students isolate the variables for themselves and to attempt to decide on one procedure for the whole class. Teacher prompting should be minimal.

Once a procedure has been devised have the class decide how to report the results. Some possibilities include: graphing of temperature against time (minute by minute results); histograms of the final start to finish times. Ask the class to decide which possibilities generate the most information.

3. Give students the list of items they have to "find" on their energy scavenger hunt. (A student worksheet is included.) You may want to limit the number of questions or add more, depending on how much time you want to spend on the activity. It is difficult to predict exactly what students will need to "prove" items 1, 4, and 5, but you should make it clear that thermometers, construction materials, etc. are available to them. The important thing is to encourage an active atmosphere of investigation.

Energy Scavenger Hunt

Find — inside and outside — your school, community, home:

1. An example of wasted energy. Prove it!
2. A good and bad use of light energy.
3. A good and bad use of heat energy.
4. An example of energy conservation. Prove it!
5. An example of energy extravagence. Prove it!
6. One thing that you could not or would not do without that uses energy.
7. One thing that you could or would do without that uses energy.
8. One thing about energy that you would like to see changed.

E/VALU/ATION

1. What does it mean to "prove" something?
2. Which did you like the best? least?
   a. The activities that involved your senses (hearing, seeing, smelling, tasting, touching).
   b. The activities that involved your feelings.
   c. The activities that required imagining, explaining, guessing, thinking, planning, and experimenting.
   d. The activities that involved a, b, and c above. What are some of your reasons?
3. How did you decide what was a good use of energy? A bad use of energy?
4. How could you celebrate a holiday without using excessive amounts of energy? What are "excessive amounts" of energy?

RE/SOURCES

Stevens, J. O. 1971 Awareness. Bantam Books, New York ($1.95)

DATA SHEET ENERGY SC/AVENGER HUNT

Find — inside and outside — your school, community, home:

1. An example of wasted energy. Prove it!
2. A good and bad use of light energy.
3. A good and bad use of heat energy.
4. An example of energy conservation. Prove it!
5. An example of energy extravagence. Prove it!
6. One thing that you could not or would not do without that uses energy.
7. One thing that you could or would do without that uses energy.
8. One thing about energy that you would like to see changed.

QUESTIONS

1. What does it mean to "prove" something?
2. Which did you like the best? least?
   a. The activities that involved your senses (hearing, seeing, smelling, tasting, touching).
   b. The activities that involved your feelings.
   c. The activities that required imagining, explaining, guessing, thinking, planning and experimenting.
   d. The activities that involved a, b, and c above.

   What are some of your reasons?
3. How did you decide what was a good use of energy? A bad use of energy?
4. How could you celebrate a holiday without using "excessive amounts" of energy? What are "excessive amounts" of energy?

KILLERWATTS

The electrical energy used by the residents of an average home is something that most of us never think about and which most of us take for granted. What does the addition of an electrical appliance to the places where we live do to our electrical costs? What are the costs to the environment? What are the social and health costs to others? What does it mean when we leave an electrical appliance on — such as a television set or an electric light — when we do not need it? What would life be like if electrical energy use were limited?

SUM/MARY

Participants outfit a home with electrical appliances with emphasis on limiting electrical energy consumption. Two activity options are provided. Students can compare their energy use with the energy used by the residents of an energy conscious home or students can compare it with energy use in their own home. This activity offers an opportunity for involvement of household members.

DE/SCRIPT/TION

GLOSSARY

Ampere — the amount or size of the flow of an electrical current; a unit of measure for electrical current per unit of time which tells how many electrons are flowing through the circuit.

Kilowatt — a unit of power, used for electric power, equal to 1,000 watts.

Kilowatt hour — 1,000 watt hours. The unit most often used when measuring electrical consumption in homes and factories. It is what an electric meter at home measures. A 100-watt lightbulb burning for 10 hours uses 1 kilowatt hour.

Volt — a measure of pressure in an electrical circuit.

Watt — a unit of power which tells how much electric power is used. Mathematically, it is the product of the voltage and amperes.

CONVERSIONS

Watts = volts x amps

$$kWh = \frac{\text{amps} \times \text{volts} \times \text{hours of use}}{1000}$$

or

$$\frac{\text{watts} \times \text{hours of use}}{1000}$$

1. Have students make two lists. The first one is a list of all the electrical appliances they have at home. The second one is a list of those electrical appliances they would like to have in their own home.

2. In order to complete this activity students will need to know how and what to read from appliance tags so that they can make some energy conversions. They will also have to make estimates of the length of time they would use each appliance in a year. Help them to be realistic about this. Help them get started looking at appliances for information on watts, volts and amps. Students will need to know some energy conversions so that the information they collect is in the same basic unit — the kilowatt hour. Review these energy conversions with them. Two options for completing this activity follow:

Option A: Have students use the list of appliances that they would like to have and which they need to outfit their own home. Then have them determine the cost in kilowatt hours per year, but with two conditions: They are not to exceed 5,486 kWh per year and their electrical use has to be enough for a family of five. The kWh's (5486) is 1,000 kWh greater than the total kWh usage in an energy conscious home of five persons: two adults, two teenagers, and one elementary school age child. Persons living in this home have all the typical electrical appliances found in most homes. They do not have an electric stove. Students can plan on using electricity to cook their food, but not to heat their water.

Option B: In this option, members of the home in which students live may want to help. Students must first find the total kilowatt hours (kWh) used in their house for one year. There is no need for them to share this information. It is important to emphasize that it is not the intent of this activity to make comparisons or judgments among households. Students can obtain this information from household electrical bills. They will have to decide whether they want to:

1. Obtain the kWh reading from a single bill and multiply it by 12.
2. Obtain one kWh reading of one month from each of the four seasons, add them, then multiply the total kWh by 3.
3. Obtain the kWh reading for each month for an entire year and add them.

Then, have the students use the list of electrical appliances that they would like to have and which they need to outfit their own living space. They then determine the cost in kWh's per year but with one condition: they are to use 1,000 kWh's less than they are presently using at home. They should assume that they are living with the same number of persons.

E/VALU/ATION

1. Can electrical appliances be used to affect people's feelings? How?
2. What did you learn about your use of electricity?
3. Complete this sentence: I was surprised that I _____
4. How would you like to live in a society where electrical energy use is regulated? Do you think it will happen? What are some of your reasons? What are some ways energy use could be regulated? Would you like them?
5. What is your household's average electrical use per day?
6. One kilogram of coal provides 1.98 kilowatt hours of electrical energy. (One pound provides 0.9 kilowatt hours.) Determine how many kilograms of coal are necessary to produce the electrical energy to run your house for one day, a week, a month, a year, and for five years.

DATA SHEET KILLERWATTS—OPTION A

GLOSSARY

Ampere - the amount or size of the flow of an electrical current; a unit of measure for electrical current per unit of time which tells how many electrons are flowing through the circuit.

Kilowatt - a unit of power, used for electric power, equal to 1,000 watts.

Kilowatt-hour - 1,000 watt hours. The unit most often used when measuring electrical consumption in homes and factories. It is what an electric meter at home measures. A 100-watt lightbulb burning for 10 hours uses 1 kilowatt hour.

Volt - a measure of pressure in an electrical circuit.

Watt - a unit of power which tells how much electric power is used. Mathematically, it is the product of the voltage and amperes.

CONVERSIONS

$$\text{Watts} = \text{volts} \times \text{amps}$$

$$\text{kWh} = \frac{\text{amps} \times \text{volts} \times \text{hours of use}}{1000}$$

$$\text{or } \frac{\text{watts} \times \text{hours of use}}{1000}$$

INSTRUCTIONS

1. Make two lists.
   a. All the electrical appliances you have at home
   b. All the electrical appliances you would like to have in the home where you would like to live.
2. Determine the kWh use per year of the place where you would like to live. You will need to use the conversions listed above Your teacher will help you learn how to read the information you need from appliances. For each of the conversions you will have to make an estimate of how many hours you will use the appliance for a year.
   a. You are not to exceed 5,486 kWh per year, but your electrical use should be enough for five persons living in your home.
   b. You may not use electricity to heat hot water but you can use it to cook food.

DATA SHEET KILLERWATTS—OPTION B

GLOSSARY

Ampere - the amount or size of the flow of an electrical current; a unit of measure for electrical current per unit of time which tells how many electrons are flowing through the circuit.

Kilowatt - a unit of power, used for electric power, equal to 1,000 watts.

Kilowatt-hour - 1,000 watt hours. The unit most often used when measuring electrical consumption in homes and factories. It is what an electric meter at home measures A 100-watt lightbulb burning for 10 hours uses 1 kilowatt hour.

Volt - a measure of pressure in an electrical circuit.

Watt - a unit of power which tells how much electric power is used. Mathematically, it is the product of the voltage and amperes.

CONVERSIONS

Watts = volts x amps

$$kWh = \frac{\text{amps} \times \text{volts} \times \text{hours of use}}{1000}$$

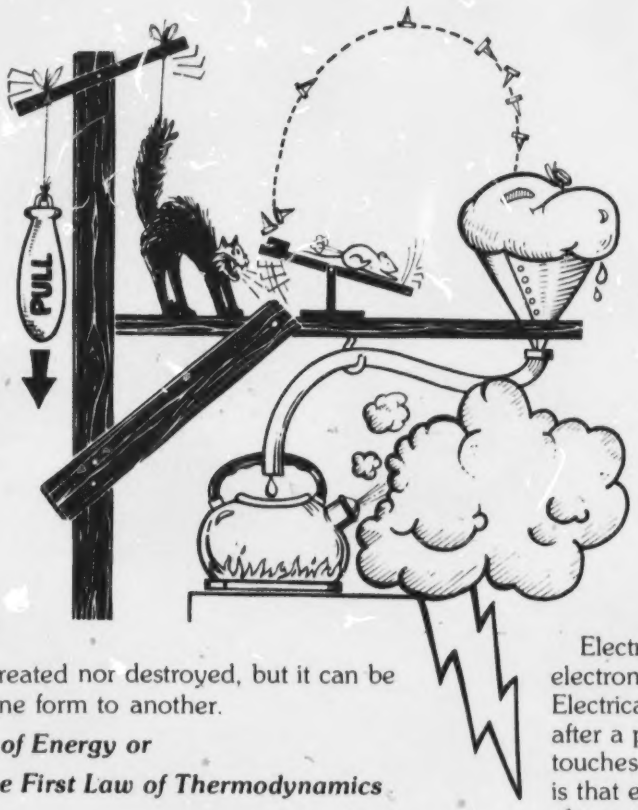
or

$$\frac{\text{watts} \times \text{hours of use}}{1000}$$

INSTRUCTIONS

1. Make two lists.
   a. All the electrical appliances you have at home.
   b. All the electrical appliances you would like to have in the home where you would like to live.
2. Find the total kWh used in your home for one year. Ask someone at home to help you. Assure this person that you are the only one who will use this information. You can obtain the amount three ways:
   a. use the kWh reading from a single bill and multiply it by 12, or
   b. use the kWh reading of one month from each of the four seasons, add them, then multiply the total kWh by 3, or
   c. add the kWh reading for each month of a year.
3. Determine the kWh used per year at the place where you would like to live. You will need to use the conversions listed above. Your teacher will help you learn how to read information you need from appliances. For each of the conversions you will have to make an estimate of how many hours you will use the appliance for a year.
   a. There is one condition: you are to use 1,000 kWh's less than you use at home.
   b. There is one assumption: you are living with the same number of persons.

RUBE'S IN(NOVA)TION



Energy can neither be created nor destroyed, but it can be transformed from one form to another.

The Law of Conservation of Energy or

The First Law of Thermodynamics

This law says that energy never disappears. It also says that energy is about change. It may flow from one place to another, e.g., from a mouse to an owl where it may be stored as fat. It may be used to fire the elaborate nervous system of the barn owl in locating the mouse as it moves across a field. It may be used by the owl to store a "memory". It may become heat in the daily living process of the owl. The point is quite simple: the total energy contributed to the owl by the mouse never disappears. It becomes redistributed and every bit of it can be accounted for, although it helps to be a physicist to do that!

All energy forms occur as either kinetic or potential energy. Kinetic energy is energy in action. It is the energy of cause and effect. A classic example is a rock rolling down a hill. Potential energy is energy which is stored. In this state, the energy is inactive. An example is a rock perched at the top of a hill. A flashlight battery is another example.

Energy exists in several forms. Four of these are: chemical, electrical, mechanical, and radiant. Chemical energy is the energy contained in chemical compounds. Gasoline, fuel oil and natural gas are examples of chemical compounds which contain a quantity of potential chemical energy. When they are used, chemical energy is released and the chemical compound is changed. Carbon compounds and water are products of energy release.

Electrical energy occurs when electrons flow along a conductor. Electrical energy is often experienced after a person walks across a rug and touches a metal object. What happens is that electrons move from the metal object to the person standing on the rug. This is kinetic electric energy. Whenever a flow of electrons is possible we can speak of it as potential electrical energy.

People have found that electrical energy has many different forms of uses because it is easily converted to other forms. For example, it can be used to heat food through the coils of an electric stove and to light living spaces with a lightbulb.

Mechanical energy is the energy of moving matter. The energy of wind is an example. Simple machines such as levers or pulleys are others. Many problems associated with machine design are associated with the transformation of mechanical energy to make its use more efficient and to reduce heat loss through friction.

Radiant energy travels in waves. It includes visible light, heat, radio waves, infrared and ultraviolet light, x-rays, gamma, and cosmic rays. Our sense organs do not detect most of these waves. Visible light and heat are two of the forms of radiant energy with which we are most familiar.

To complete this story it should be added that each energy conversion includes a heat loss or a heat tax. The significance of the heat tax and what it means to us as we use fossil fuels or, for that matter, any fuel resource is not an easy concept to grasp. A hot object such as a furnace cools off as heat is transferred from it to a whole object: the house, school, or office. The heat eventually escapes from the building and is lost. The use of incandescent lightbulbs provides another example. As electrical energy is converted to light energy, the bulb and the area around the bulb become considerably warmer. As a matter of fact, only five percent of the electrical energy entering the filaments of a 100-watt incandescent lightbulb is converted to light; the rest is lost to the surroundings as heat. This is an expensive energy conversion.

It is because heat dissipated through the earth's atmosphere as energy is convered from one form to another that we can run out of energy. Otherwise, according to the first law, we would have an endless supply.

SUM/MARY

In this open and free-ranging activity students design/invent an energy converter which uses an energy resource such as wind, gravity, the sun, which demonstrates the first law of energy — energy can neither be created nor destroyed but it can be transformed from one form to another. Parents, neighbors, older brothers and sisters can be invited to help and participate in the proceedings. A short activity on change as a match or candle burns sets the stage for the student investigation.

DE/SCRIPT/ION

Some materials needed: A rich and diverse collection of parts, cardboard, wire, nuts, bolts, nails, cans, wood pieces, tools — perhaps everything except the kitchen sink! You or your students may have to scrounge the parts you need.

This activity assumes that you and the class have considered the first law of energy and also that you have considered forms of energy.

1. To introduce the idea of energy conversion, you could light a match or a candle and ask students to watch it burn. They are to make as many observations as they can. A partial list of observations follows:

1. How many colors can they see in the flame?
2. Does the flame burn clearly or does it smoke?
3. Is the top surface of the candle even or is there a depression in it?
4. As the candle burns, what happens to the wick?
5. What changes of energy have occurred?
6. What forms of energy do you see or feel?
7. Where do these forms of energy observed in 6 come from?
8. Is energy taken in or given out?
9. Is the candle an invention that transforms energy from one form to another? What is it changing from . . . to . . . ?

2. Challenge your students to devise/invent/build a device which transforms energy from one form to another and to prove that it does it. The device can tap both usual energy sources such as wood and the less usual but much talked about sources such as wind or the sun. Parents, neighbors, older brothers and sisters can be invited to help and to participate in the proceedings. When you start this activity it may be slow going and not easy for your students. Be ready to help.

E/VALU/ATION

1. Did you create energy? How do you know that you did or did not?
2. Did you transform energy from one form to another?
3. How do you know that energy is being used by your invention?
4. When energy is being used, how do you know that it is being changed? Changed to what?

ENERGY: WHA(TT) IS IT(?)

Energy is . . . (energy?) Concern about energy surrounds us. News of the energy crisis bombards us through our newspapers, magazines, radio and television. We attempt to conserve it. We spend increasing amounts of money for it. We know that it has something to do with heat, motion and light. It can mean one thing to a scientist interested in ways heat is transferred. To a politician interested in energy policy, it is a crisis. It can be seen, smelled, felt, heard and tasted. But what is it?

There are two kinds of energy: kinetic and potential. Energy in motion is referred to as kinetic energy. It is the energy of action. Kinetic energy is the energy felt and observed in the heat and light of a fire. Energy which we can use is kinetic energy. Energy which is stored, for example, in flashlight or automobile batteries or in a lump of coal, is known as potential energy. It may be thought of as inactive energy — energy that is waiting; energy that is ready to go. This is the energy of storage.

Energy is also about flows and changes. If energy did not flow; if it were not capable of being changed from potential energy to kinetic energy, the world would be a quiet (and also lifeless) place. We take advantage of energy flows and energy changes. Think about the light coming from a lightbulb. Moving electrons (kinetic energy) in the wires of a lightbulb release heat and light. The electricity comes from an electric generator turned by a steam turbine (kinetic energy). Steam heat — kinetic energy — from the furnace of a power plant was changed to mechanical energy. The heat energy of steam may have come from energy stored (potential) in coal or oil.

Dunagin's People by Ralph Dunagin
Courtesy of Field Newspaper Syndicate

Energy not only flows; it also changes forms. In the example above, the chemical energy contained in coal was changed into steam heat. The heat was used to drive a turbine and it was changed into a new form — mechanical energy. The mechanical energy of the turbine turned an electrical generator and electricity was released. Finally, the electrical energy became the radiant energy of the lightbulb. The sequence of change of the energy forms in this example is chemical, mechanical, electrical and radiant.

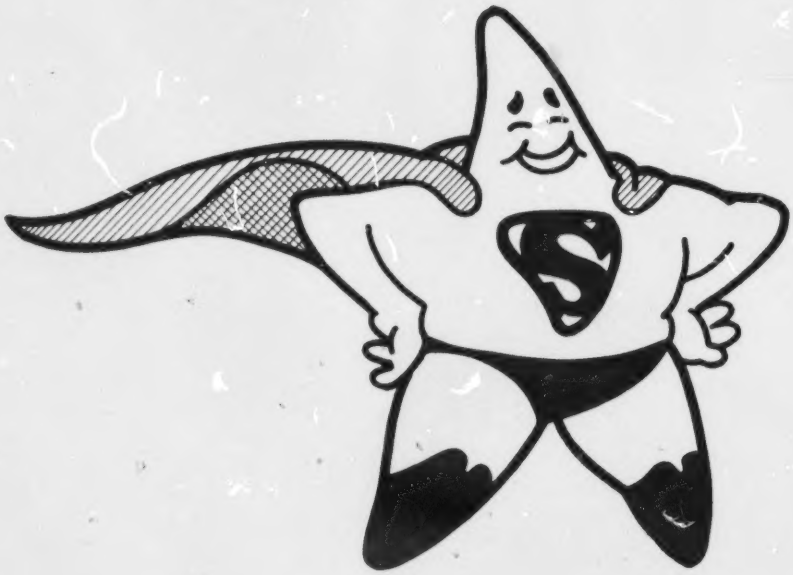
These flow and change processes are controlled by two laws which, as Jean Matthews has pointed out, "rank along with gravity as laws that will not be repealed in your lifetime or mine."

The first of these laws is the Conservation of Energy Law or the First Law of Thermodynamics. It says:

Energy can be neither created nor destroyed.

The Conservation of Energy Law is

STAR POWER



The sun's energy is used to do much work which we take for granted. The heating of the atmosphere by the sun results in temperature differences in the air, creating winds which are responsible for our weather and climate. The circulation of rain and water, known as the hydrologic cycle, is powered by solar energy. Visible light is used by plants to manufacture food on which all life, directly or indirectly, depends.

Solar energy is also increasingly being considered as an alternative source of energy for generating electricity, heating homes and water, and cooling. The energy of the sun is virtually limitless. It will last nearly as long as the sun shines.

But there are some interesting problems in converting solar energy into forms which people find useful. Solar energy is dilute and needs to be collected and concentrated. Solar collectors for a large capacity generating facility require a large collecting area. Solar energy is also interrupted by clouds (unpredictable) and the daily rotational cycle (predictable) of the earth. In order to ensure a dependable supply, the energy captured by collectors must be stored or supplemented by other energy back-up systems.

We already make use of solar energy in our homes. It enters through our windows and adds heat in both the summer and winter. The exclusive use of solar energy to heat Minnesota homes is not economical at present, and most present-day systems require furnaces for supplemental heating in homes equipped with solar energy panels.

One of the things we need to do is better understand solar energy. What is it? What are the ways that it can be used both as an enhancer and as an extender of our present fuel systems?

In using solar energy there are three primary considerations:

1. the energy must be collected and concentrated,
2. the energy must be stored, and
3. the energy must be transferred and distributed.

One way to learn more about solar energy is from a solar heat collector. A solar collector is a sealed container with an internal dull black surface and a cover of glass or other transparent material. Solar heat collectors are very similar to greenhouses or closed cars on hot days in the way that they work.

Sunlight (short light wave radiation) passes easily through glass. It is converted into longwave radiation or heat. Because both the greenhouse and the car are closed to air circulation, little heat is lost through convection. In addition, glass is also not a good heat conductor of longwave radiation. Both the greenhouse and the car stay warm.

There are many practical uses of solar heat collectors and these are illustrated in Figures 1 - 3.

In Figure 1 a wooden box with a glass top is constructed so that it fits in a window. The box is divided into a upper and lower section by a sheet of wood which is painted black on top. Sunlight is used to heat the air over the black wood. The heated air then flows into the house and as this air enters the room, cooler air from the floor of the room is pulled into the box and circulated through the system. Heat is exchanged as this occurs.

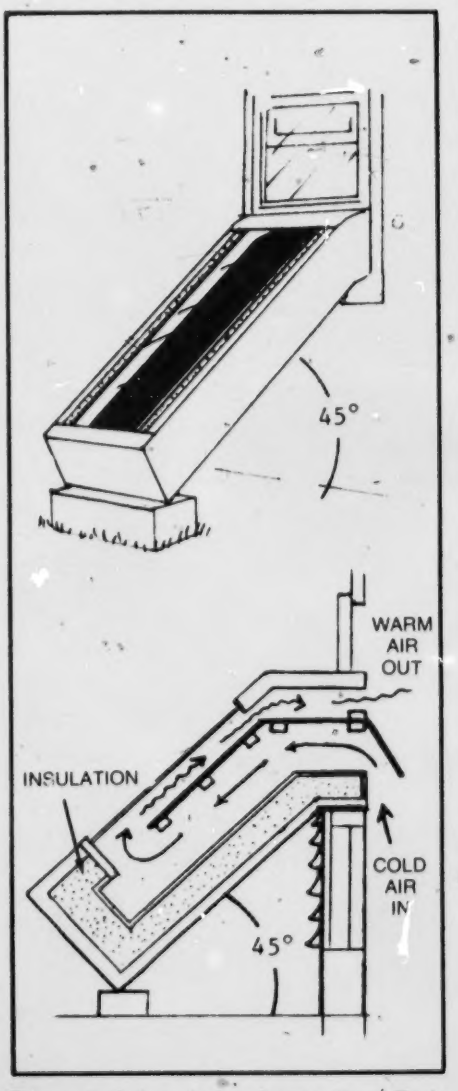


Figure 1. Solar window heater (from Eccli and Eccli, 1974:35)

The wall heater in Figure 2 makes use of the wall space on the south side of a home. A box is built on the side of the house. The inside of the box is painted flat black and storm windows are used as covers for the system.

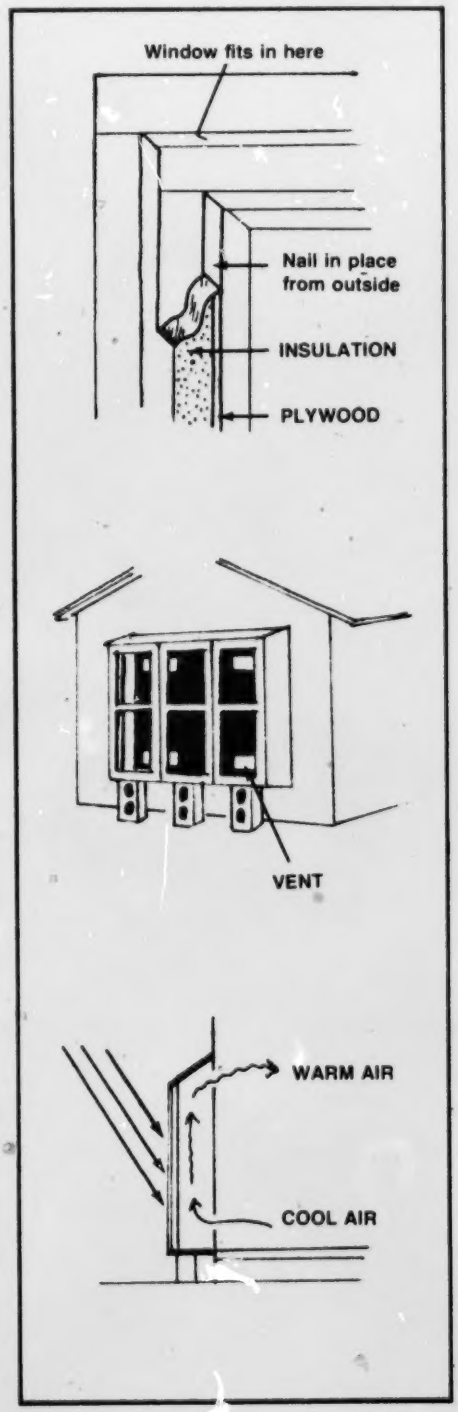


Figure 2. A wall window heater (from Eccli and Eccli, 1974:37)

In Figure 3 a solar collector is shown for a home. Collection and heating is accomplished by flat collectors, and water pipe transports the heat energy to a storage compartment in the house.

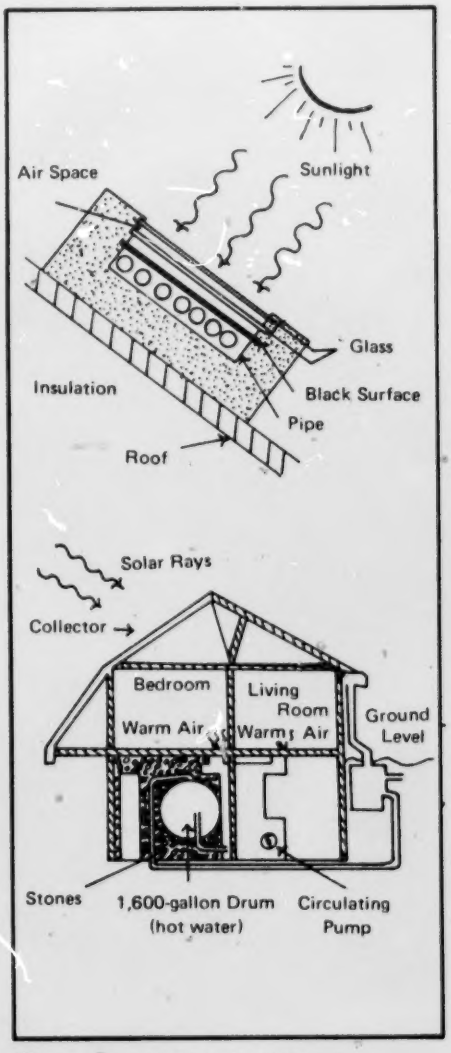


Figure 3. Solar heat collector for a house (Figure 7-3; Fowler, J. W. 1975:210)

SUM/MARY

In this activity participants construct a simple solar heat collector and take some temperature measurements.

There are two activity options. In the first one students improve upon the heat collecting and retaining ability of a simple heat collector. In the second, specific instructions for constructing a solar heat collector are given. A student worksheet which can be duplicated is included for both options.

DE/SCRIPT/ION

Some materials needed:

Boxes — assorted sizes and shapes (shoe, cigar, shirt, etc.);
paints — flat, poster, assorted colors
window glass
clear plastic wrap
black plastic sheeting
thermometers — candy and/or regular;
glazing compound
modeling clay
graph paper
aluminum foil
scissors
insulation — vermiculite, fiberglass, mineral wool, cellulose, etc.
(CAUTION: Wear gloves when handling fiberglass and mineral wool insulation.)
tape — wrapping, and/or masking
corrugated cardboard
white glue
packing materials — styrofoam beads or elbows
egg cartons
stones, gravel and sand, etc.

Option 1: After you take the temperature inside an empty box, place the box in a sunny window. After the box has been there for a while take the temperature again. Share the temperature information with your class. Challenge your students to improve upon the design of the box. Be sure you have a variety of materials available for them to work with. Students are to do these things:

a. raise the temperature of the air inside the box

b. retain the heat collected in the box

c. construct an observation sheet and record measurements they take. They should record temperatures and times until the temperature stops rising in the box they construct. They should also be able to show that they were able to retain the heat collected.

Option 2: Have students paint the inside of the box with a flat black paint. After the paint is dry, a thermometer is placed in the box. Tape the thermometer down but be sure that it is located so that the temperature can be read.

If you do not have enough thermometers for the class, have students build a small door on one side of the solar heat collector so that the thermometer can be moved from one box to another. Cut an opening so that the door can be shut after temperature reading is taken. A small tab of masking tape can be used as a handle for the door.

SOME MEASUREMENTS

Help your students construct an observation sheet. Some suggested measurements follow. Emphasize the importance of recording all pertinent observations.

1. Record the temperatures and times inside and outside the box until the temperature inside the box stops rising. Make a graph of temperature against time.

2. Take the box out of the sun. How fast does the temperature change?

3. Vary the angles of the box with the surface of the ground. Take measurements when the box is at the horizontal, at 30 degrees, at 45 degrees, at 60 degrees, and at 90 degrees.

4. Try to find out what time of day the difference between the inside and the outside temperature is greatest.

5. Try the collector at different times throughout the year. Try the collector once each week for a month. What are some of the variations in temperature that are observed?

SOME M/OR/E

1. Try constructing a collector with two transparent covers. A bead of clay about the thickness of your finger can be used to separate the two pieces of glass. How much better is this collector than single covered collectors?

2. Insulate the collector. Fit it in a larger box and surround it with an insulating material. In what way(s) does this improve the collector?

3. Vary the colors used to paint the inside surfaces of the box and note the temperature differences. Which color works best? What are some reasons for this?

4. Compare different boxes and designs with each other. Which one is most efficient? Which gains the most heat? What are some reasons for this? Which loses heat most rapidly?

5. Try a solar heat collector in the winter time on the school playground or on any hard surface such as concrete. Take measurements and record. Now try the same experiment but with a small snow bank piled in front of the box. Does the box heat faster with or without the snow? Is the final temperature higher with or without the snow? What are some reasons for this?

6. Try different corrugated and textured surfaces in the box. Glue plastic packaging beads/elbows to the inside of the box and paint them. Compare temperatures of collectors with pieces glued to corrugated surfaces and smooth surfaces. Glue rocks/sand inside the boxes and note temperature and heating differences.

E/VALU/ATION

1. In what way does the sun affect you?
2. Which passes more easily through the transparent top of the heat collector — light or heat? On the basis of what you did how do you know?
3. What is a solar heat collector? How do you know one when you see it?
4. The sun is the answer to the energy crisis because of the huge reserves of sunlight. Do you agree or disagree? What are some of your reasons?

RE/SOURCES

Eccli, E. and S. Eccli. 1974. Save energy, save money. The National Center for Community Action, 1711 Connecticut Avenue, N.W., Washington, D. C. 20009 or Institute on Energy Conservation and the Poor, Office of Economic Opportunity, Washington, D. C. 20506.

Fowler, J. W. 1975. Energy-environment source book. National Science Teachers Association, 1742 Connecticut Avenue N.W., Washington, D. C. 20009 ($4.00)

Prenis, J. (Ed.). 1975. Energybook #1: Natural sources and backyard applications. Running Press, 38 South Nineteenth Street, Philadelphia, PA 19103 ($4.00)

Prenis, J. (Ed.) 1976. Energybook #2: Natural sources and backyard applications. Running Press, 38 South Nineteenth Street, Philadelphia, PA 19103 ($5.00)

DATA SHEET STAR POWER—OPTION A

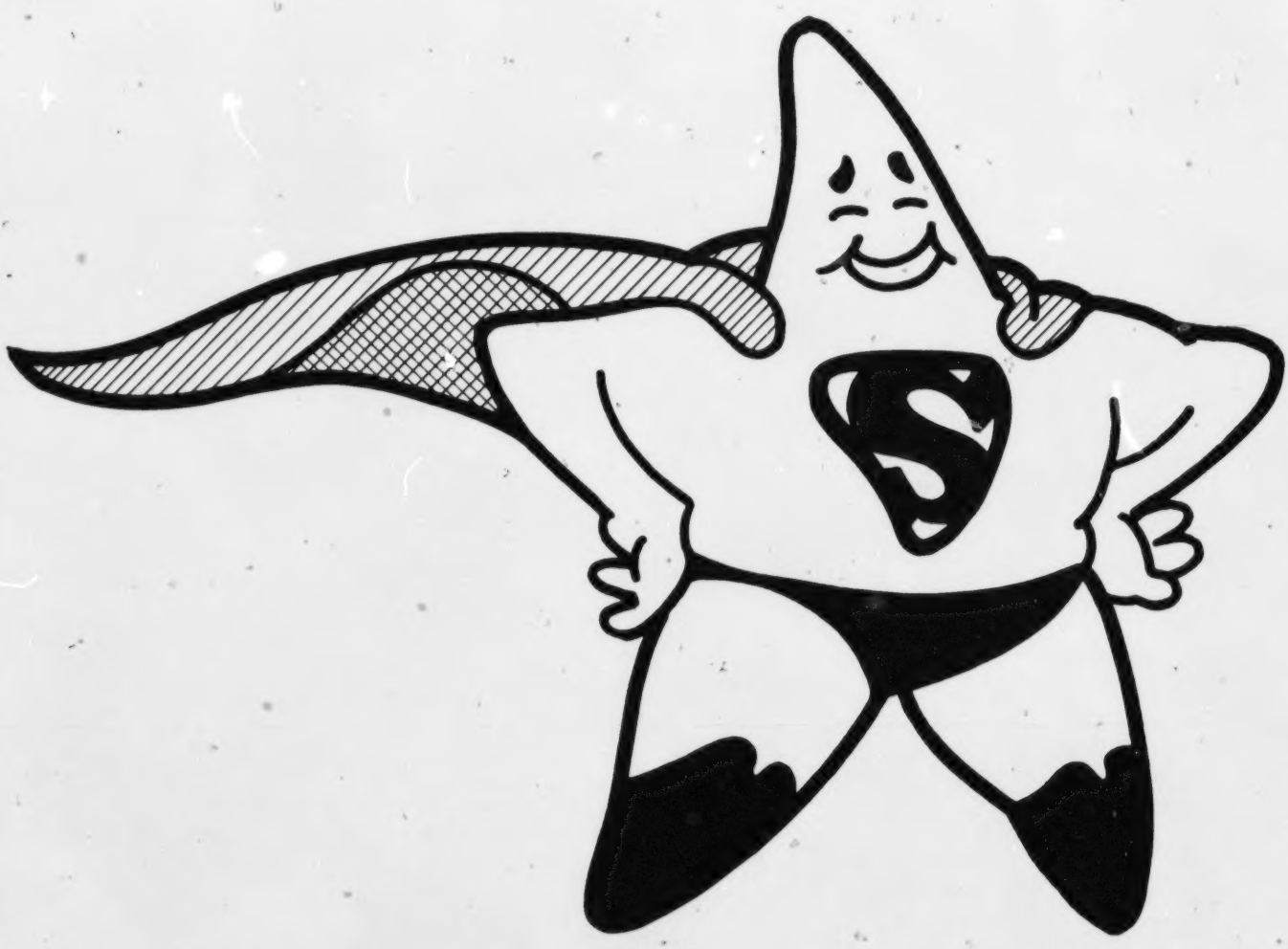
YOUR ASSIGNMENT:

Your teacher has shared two temperature measurements taken inside an empty box with you. You are to improve upon the design of the box and show that you have done it by:

1. Raising the temperature of the air inside the box.
2. Retaining the heat collected in the box.

You are to construct an observation sheet on which you record the measurements you take. Be sure to a) record temperatures and times until the temperature stops rising, and b) record temperature and times to show that you were able to retain the heat collected.

Your teacher will have a variety of materials available for your use. You can use anything else you can find. The only energy you can use to heat the box is sunlight.



DATA SHEET STAR POWER—OPTION B

A Solar Heat Collector

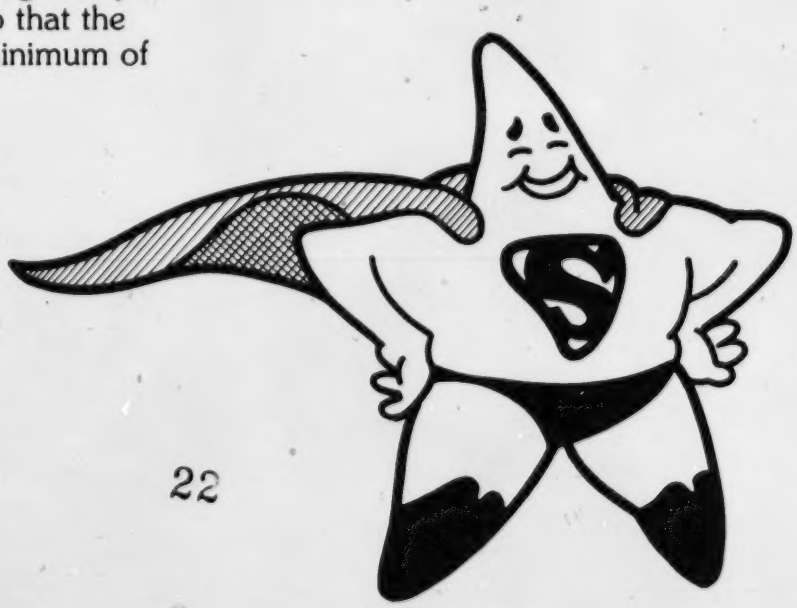
1. Paint the inside of the box with a flat black paint. After the paint is dry, place a thermometer in the box and tape it in place. The bulb should be placed so that it is not in the direct light of the sun. Be sure that you can read the thermometer.

If there are not enough thermometers for everyone, build a small door on one side of the solar heat collector so that a thermometer can be moved from one box to another. Cut an opening in the side of the box so that the door can be shut after you take a reading. Use a small tab of masking tape as a handle for the door.

Cover the box with a piece of glass or plastic type food covering. If you use glass, cover the edges with masking tape. If you use a box which has a cover, make a hole in it that is a little smaller than the top of the box. You can then mount the glass window over the opening with masking tape.

It is important to make the seal between the box and the covering as air tight as you can. Place the box in the sun so that the glass top faces the sun with a minimum of shadows inside the box.

2. Make the following measurements:
   a. Record the temperatures and times inside and outside the box until the temperature inside the box stops rising. Make a graph of temperature against time.
   b. Take the box out of the sun. Make a graph which shows how fast the temperature changes.
   c. Vary the angle of the box with the surface of the ground. Take measurements when the box is at the horizontal, at 30 degrees, at 45 degrees, at 60 degrees.
   d. Try to find out what time of day the difference between the inside and the outside temperature is greatest.
   e. Try the collector at different times throughout the year. Try the collector once each week for a month. What are some of the variations in temperature you observe?



PURPOSE . . . to help promote knowledge about energy, provide laboratory experiences, provoke inquiry and to relate energy to society through the science curriculum.

WHAT . . . . . six activities, short (1-3 class periods), teacher initiated, student worksheets, individual and group participation. Each has some background, instructions, and evaluation questions which emphasize sharing and clarification of values.

VALUES CLARIFICATION . . . Students should always have the right to pass; all answers are acceptable (not right or wrong); leaders should participate but should be willing to pass at the beginning so students learn to respond freely and not try to "guess the right answer". Sure, you (and students) can correct errors of fact.

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